

Claim Amendments

1. (Previously presented) An oscillatory neural network computer, comprising:
a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and
a plurality of phase-locked loop circuits operably coupled with said weighting network;
the weighting network having inputs operably coupled to outputs of the phase-locked loops and having outputs operably coupled to inputs of the phase-locked loops.

2. (Previously presented) An oscillatory neural network computer, comprising:
a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and
a plurality of phase-locked loop circuits operably coupled with said weighting network, wherein the weighting network comprises:
first and second weighting circuits, each of the first and second weighting circuits having input and output terminals;
a first adder circuit having first and second input terminals and an output terminal, the first input terminal of the first adder circuit coupled to the output terminal of the first weighting circuit and the second input terminal of the first adder circuit coupled to the input terminal of the second weighting circuit; and
a first bandpass filter circuit having input and output terminals, the input terminal of the first bandpass filter circuit coupled to the output terminal of the first adder circuit.

3. (Previously presented) The oscillatory neural network computer of claim 2, further including:
third and fourth weighting circuits, each of the third and fourth weighting circuits having input and output terminals;
a second adder circuit having first and second input terminals and an output terminal, the first input terminal of the second adder circuit coupled to the output terminal of the

third weighting circuit and the second input terminal of the second adder circuit coupled to the input terminal of the fourth weighting circuit; and

a second bandpass filter circuit having input and output terminals, the input terminal of the second bandpass filter circuit coupled to the output terminal of the second adder circuit.

4. (Previously presented) The oscillatory neural network computer of claim 2, wherein the plurality of phase-locked loop circuits comprises a phase-locked loop circuit having an output terminal coupled to the input terminal of the first weighting circuit.

5. (Previously presented) The oscillatory neural network computer of claim 4, further including a first initialization input terminal coupled to the first adder circuit.

6. (Previously presented) An oscillatory neural network computer, comprising:

a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and

a plurality of phase-locked loop circuits operably coupled with said weighting network, wherein the weighting network comprises a plurality of weighting circuits coupled to a plurality of bandpass filter circuits through a plurality of adder circuits.

7. (Previously presented) The oscillatory neural network computer of claim 6, wherein each weighting circuit comprises a linear amplifier.

8. (Previously presented) The oscillatory neural network computer of claim 7, wherein each weighting circuit further comprises a phase shift circuit coupled to the linear amplifier.

9. (Previously presented) An oscillatory neural network computer, comprising:

a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and

a plurality of phase-locked loop circuits operably coupled with said weighting network, wherein the network comprises a plurality of phase shift circuits each phase shift circuit connected in a weighting circuit operably connected to an input of one of the phase-locked loops.

10. (Previously presented) The oscillatory neural network computer of claim 1, wherein the weighting circuit further includes a plurality of initialization input terminals.

11. (Previously presented) An oscillatory neural network computer, comprising:

a plurality of connectors, wherein each connector has a phase-encoded connection coefficient; and

phase-locked loops having a plurality of oscillators operably coupled with said plurality of connectors, each of the connectors having means for establishing a gain and a phase shift circuit.

12. (Previously presented) An oscillatory neural network computer, comprising:

a plurality of connectors, wherein each connector has a phase-encoded connection coefficient;

a plurality of oscillators operably coupled with said plurality of connectors; and

a plurality of adder circuits coupled between the plurality of connectors and said plurality of oscillators.

13. (Currently amended) ~~The oscillatory neural network computer of claim 12, further including~~ An oscillatory neural network computer, comprising:

a plurality of connectors, wherein each connector has a phase-encoded connection coefficient;

a plurality of oscillators operably coupled with said plurality of connectors;

a plurality of adder circuits coupled between the plurality of connectors and said plurality of oscillators; and

a plurality of bandpass filter circuits coupled between said plurality of adder circuits and said plurality of oscillators.

14. (Previously presented) The oscillatory neural network computer of claim 13, wherein the plurality of connectors comprises first, second, third, and fourth connectors, the plurality of adder circuits comprises at least two adder circuits, and wherein the output terminals of first and second connectors are coupled to the input terminals of a first adder circuit and the output terminals of third and fourth connectors are coupled to the input terminals of the second adder circuit.

15. (Previously presented) The oscillatory neural network computer of claim 14, wherein the plurality of oscillators includes a first oscillator having an output terminal coupled to the first and third connectors and a second oscillator having an output terminal coupled to the second and fourth connectors.

16. (Previously presented) The oscillatory neural network computer of claim 15, further including a first initialization terminal coupled to the first adder circuit and a second initialization terminal coupled to the second adder circuit.

17. (Previously presented) An oscillatory neural network computer, comprising:
a plurality of connectors, wherein each connector has a phase-encoded connection coefficient;
a plurality of oscillators operably coupled with said plurality of connectors; and
the plurality of connectors comprises a linear amplifier coupled to a phase shift circuit.

18. (Previously presented) A method for recognizing an incoming pattern using a neural network computer comprising using a phase deviation between signals representing a learned pattern and signals representing the incoming pattern to create an output signal indicative of the learned pattern.

19. (Previously presented) The method of claim 18, wherein using the phase deviation includes encoding connection coefficients of the neural network computer in accordance with phase representations of the signals representing a learned pattern.

20. (Previously presented) A method for programming a neural network computer comprising encoding connection coefficients of the neural network computer in accordance with phase relationships of signals representing a pattern to be learned.

21. (Previously presented) The method of claim 18, further comprising providing an oscillatory neural network, initializing the network by applying initializing signals to multiple initializing inputs, and after initializing feeding back to multiple connector outputs of multiple phase-locked loops amplifying, at the connectors, the outputs fed back thereto, phase shifting the outputs fed back thereto and applying the amplified, phase-shifted outputs to inputs of the phase-locked loops.

22. (Previously presented) The method for programming a neural network computer in accordance with claim 21, wherein encoding connection coefficients comprises establishing the gains of a plurality of amplifiers connected between outputs of a plurality of phase-locked loops and a plurality of inputs to the phase-locked loops.

23. (Previously presented) The method of programming a neural network computer according to claim 22, further comprising applying the outputs of individual phase-locked loops to multiple amplifiers connected to inputs to the multiple phase-locked loops.

24. (Previously presented) The method of programming a neural network computer according to claim 23, further comprising phase-shifting the outputs of the phase-locked loops being applied to inputs to the multiple phase-locked loops.

25. (Previously presented) An oscillatory neural network computer, comprising:

a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and

a plurality of phase-locked loop circuits operably coupled with said weighting network,

wherein the weighting network comprises plurality of weighting circuits having input terminals operably coupled to the output terminals and output terminals operably coupled

to the phase-locked loop circuits, the weighting circuits having an output voltages of substantially the form:

$$V(\theta) = S_{kj} * V(\theta + \psi_{kj})$$

where:

S is gain of the weighting circuit, and ψ is phase shift introduced by the weighting circuit.

26. (Previously presented) The oscillatory neural network computer according to claim 25, wherein each weighting circuit comprises an amplifier operably coupled to one of the output terminals and a phase shift circuit operably coupled to one of the phase-locked loops, the amplifier having substantially the gain S and the phase shift circuit having substantially the phase shift ψ .

27. (Previously presented) The oscillatory neural network computer according to claim 26, wherein the phase shift circuit is operably coupled to the one of the phase-locked loops through an adder circuit and a band pass filter.

28. (Previously presented) An oscillatory neural network computer, comprising:
a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and
a plurality of phase-locked loop circuits operably coupled with said weighting network,
wherein the neural network is a dynamic system that is described mathematically substantially as:

$$d \theta_k(t)/dt = \Omega + V(\theta_k) \sum_{j=1}^n S_{kj} * V(\theta_j - \pi/2)$$

for $k=1, \dots, N$, where:

θ_k is the phase of a VCO embedded in the k^{th} PLL circuit;

θ_j is the phase of the VCO embedded in the j^{th} PLL circuit;

Ω is the natural frequency of the VCO in MegaHertz (MHz);

S_{kj} are the connection strengths; and
 $V(\theta)$ is a 2π periodic waveform function.

29. (Previously presented) The oscillatory neural network computer according to claim 28, wherein the weighting network comprises a plurality of weighting circuits, each of the weighting circuits comprising an amplifier operably coupled to one of the output terminals and a phase shift circuit operably coupled to one of the phase-locked loops.

30. (Previously presented) The oscillatory neural network computer according to claim 29, wherein each phase shift circuit is operably coupled to the one of the phase-locked loops through an adder circuit and a band pass filter.

31. (Previously presented) An oscillatory neural network computer comprising a plurality of n phase-locked loops, where n is a positive number in excess of 3, a plurality of n adder circuits, a plurality of n^2 weighting circuits operably connecting an output of each of the phase-locked loops to each of the n adder circuits, and a plurality of n initialization input terminals each connected to one of the adder circuits.

32. (Previously presented) The oscillatory neural network computer according to claim 31, wherein each weighting circuit includes an amplifier and a phase shift circuit operably coupled between the phase-locked loop outputs and one of the adder circuits.

33. (Previously presented) The oscillatory neural network computer according to claim 32, wherein each adder circuit is operably coupled to a phase-locked loop through a band pass filter.

34. (New) An oscillatory neural network computer, comprising:
a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and
a plurality of phase-locked loop circuits operably coupled with said weighting network;
the weighting network being outside the phase-locked loop circuits and having inputs operably coupled to outputs of the phase-locked loops and having outputs operably coupled to inputs of the phase-locked loops.

35. (New) An oscillatory neural network computer, comprising:
a weighting network having a plurality of output terminals, the weighting network having phase-based connection strengths; and
a plurality of phase-locked loop circuits operably coupled with said weighting network, wherein the network comprises a plurality of phase shift circuits each phase shift circuit connected in a weighting circuit external to the phase-locked loop circuits operably connected to an input of one of the phase-locked loops.